

RESEARCH NOTE NC-34

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101

CHEMICAL WEED CONTROL INCREASES SURVIVAL AND GROWTH
IN HARDWOOD PLANTINGS

ABSTRACT.—In a plantation of four hardwood species on a silt loam soil planted to 1-0 stock, 4 pounds of active atrazine or simazine controlled weeds effectively without injuring the trees. Chemical weed control was better on plowed and disked ground than on unprepared ground. Yellow-poplar and white ash grew faster on prepared ground. Black walnut and red oak did not respond to ground preparation treatments. Guides are presented for proper use of the chemicals in establishing hardwood plantations.

Weed competition can seriously reduce survival and growth of newly established hardwood plantations in Iowa. Weeds and grasses compete strongly with planted trees for moisture, light, and nutrients, especially during the period of establishment. Dense weed patches also provide food and cover for rodents, which often injure or destroy newly planted trees.

Machine cultivation, mowing, and scalping around individual trees have effectively controlled weeds in the past. Newer chemical weed control methods are cheaper than mechanical methods but require more knowledge and skill to use safely and effectively.

In April 1963 we established a study on an abandoned old-field site in east-central Iowa. At that time smooth brome grass (*Bromus inermis* Leyss) was the main ground cover. The soil is classified as Clinton silt loam. Two ground preparation and six weed control treatments were applied to determine the most effective combination of treatments as evaluated by survival and height growth of black walnut (*Juglans nigra* L.), red oak (*Quercus rubra* L.), yellow-poplar (*Liriodendron tulipifera* L.), and white ash (*Fraxinus americana* L.). Besides presenting study results, this Note outlines procedures for proper application of the weed control chemicals.

Methods

A split-split-plot design in randomized blocks was used. Each of five blocks was divided into two main plots. Ground preparation treatments assigned to main plots were:

1. Fall plowing plus spring disking and harrowing.
2. No ground preparation (brome grass sod cover).

Main plots were divided into six weed control sub-plots each 12x42 feet. The six weed control treatments were:

1. Simazine,¹ 4 pounds per acre.
2. Simazine, 2 pounds per acre.
3. Atrazine,¹ 4 pounds per acre.
4. Atrazine, 2 pounds per acre.
5. Black plastic mulch (26½-inch squares).
6. No weed control.

The weed control plots were separated from each other by 3-foot isolation strips, and the ground preparation blocks by 12-foot isolation strips.

Early in April, the herbicides were uniformly sprayed over each sub-plot. Then, with a Lowther tree planter, 14 one-year-old, uniformly graded seedlings of each species were planted in each sub-plot at 3x3-foot spacing.

The herbicides were activated by 1 inch of rain, which fell within 11 days after herbicide application.

In each mulching sub-plot, black polyethylene tree mulch squares (26½x26½x.022-inch thick)

¹ The chemical name for simazine is 2-chloro-4, 6-bis (ethylamino)-s-triazine; for atrazine it is 2-chloro-4-ethylamino-6-isopropylamino-s-triazine. Sprays were made from the 80-percent wettable powder, but all rates are given in pounds of active ingredients.

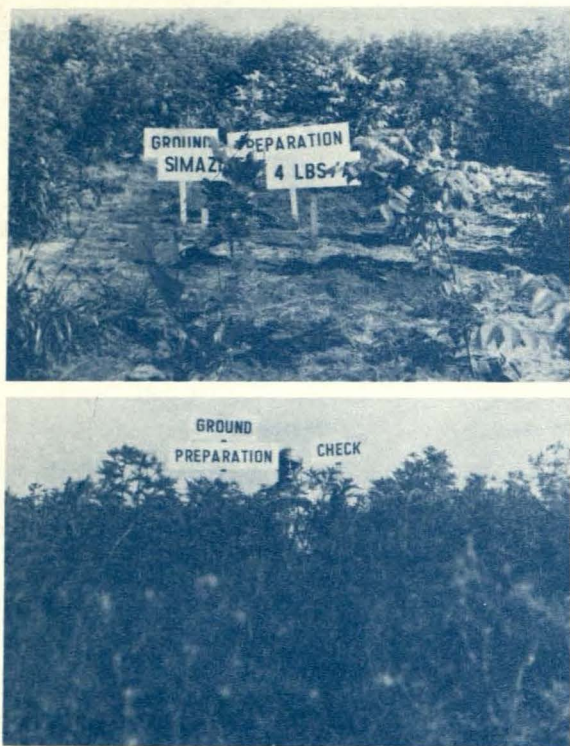


Figure 1.—Weed control 110 days after treatment was applied on prepared ground. Note the dense weed growth on the check plot (no herbicide) as compared to the plot where simazine was applied. Atrazine at the 4-lb. rate gave results similar to the simazine treatment.

were placed around 56 seedlings (560 trees total) in a manner such that the plastic did not touch the stems. Soil was used to anchor the plastic on tilled plots, and wire pins held the plastic in place over the sod on untilled plots.

Chemicals Successfully Controlled Weeds

The four species grew best on plots treated with 4 pounds per acre of simazine or atrazine. At the 4-pound rate, atrazine provided a full season of weed control, but when the herbicides were applied to prepared ground, simazine was as good (fig. 1). On unprepared ground, atrazine, which is absorbed through the foliage and roots, was more effective against established brome grass than was simazine, which is absorbed only through the roots (Davis *et al.* 1959).

For both chemicals, the 2-pound rate did not result in as effective or long lasting control as the 4-pound rate. Most weed control treatments improved second-year height and two-year basal diameter growth of hardwood trees (table 1). No

symptoms of chemical injury to any of the trees were visible.

Neither weed control nor ground preparation treatments affected 2-year survival of black walnut or red oak trees. At least 80 percent of the walnut trees and 71 percent of the oak trees survived regardless of treatment. However, in plots without herbicides trees died back repeatedly, were stunted, and probably will be gradually eliminated by weed competition and by rabbits and mice that thrive in the weed cover. Significant differences in mean survival rates among treatments were found for white ash and yellow-poplar trees (table 2).

Even the best weed control treatments failed to provide any residual weed control during the second growing season. Spring herbicide applications at the beginning of the second season probably would have increased tree growth.

Survival and growth of plastic-mulched trees generally were the same as for control trees. Apparently, the 26½-inch squares of black plastic were not large enough to be effective. Black plastic is expensive and requires more time to install than herbicide treatments.

Responses to ground preparation and weed control treatments varied by species. Where weeds were eliminated, yellow-poplar, white ash, black walnut, and red oak grew 44, 33, 17, and 11 inches, respectively, in 2 years compared to 2 inches or less growth on plots with no weed control. Yellow-poplar and white ash seedlings grew rapidly in height, but black walnut and red oak were slower starters.

Most walnut trees died back the first year, but the amount of dieback was less severe where weeds were chemically controlled than on plots with less effective control. Furthermore, during the second growing season, the trees showed large height growth responses to chemical weed control.

Red oak trees grew faster during the second growing season on plots treated with 4 pounds per acre of atrazine than on untreated plots. Growth probably would have been greater had larger stock been used. Stem diameters of our planting stock averaged only 4/32 inch. This is 3/32 inch smaller than the preferred planting stock grade for red oak (Limstrom 1963).

Ground Preparation Was Important

Better chemical weed control was obtained on prepared ground than on unprepared ground. Where no herbicide was applied, ragweed and fox-tail grasses rapidly invaded prepared ground. On mulch plots, where only a 26½-inch square around

Table 1.—Average 2-year basal diameter growth and second-year height of planted hardwood trees by weed control treatment¹

Weed control treatment	Yellow-poplar		Black walnut		Red oak		White ash	
	Height	Diameter	Height	Diameter	Height	Diameter	Height	Diameter
	Inches	32nds	Inches	32nds	Inches	32nds	Inches	32nds
Atrazine 4 lb/A	48*	19*	40*	16*	17	2	31*	12*
Simazine 4 lb/A	37*	12*	32*	12*	14	2	26*	10*
Atrazine 2 lb/A	29*	7	29*	8*	13	1	20*	7
Simazine 2 lb/A	29*	7	23	4	11	1	17	5
Plastic mulch	17	1	14	0	8	0	13	3
No weed control	16	0	13	0	8	0	8	0
All treatments ^{2/}	2.0	1.2	1.4	1.0	0.5	0.1	1.4	0.8

^{1/} Basal diameter was measured in 32nds of an inch at a point 1 inch above ground line.

^{2/} Standard error for each mean in a column.

* Significantly different (.05 level) from the no weed control and plastic mulch treatments, using Keuls test as explained by Snedecor (1956). Mean is based on 140 planted trees.

Table 2.—Average second-year survival of white ash and yellow-poplar seedlings by ground preparation and weed control treatment

Ground preparation treatment	Weed Control treatment	Percent survival	
		White ash	Yellow-poplar
Plow and disk	Plastic mulch	80*	54*
Plow and disk	Simazine 4 lb/A	76*	76*
Plow and disk	Simazine 2 lb/A	74*	67*
None	Atrazine 2 lb/A	72*	56*
Plow and disk	None	67*	39*
None	Atrazine 4 lb/A	64*	59*
Plow and disk	Atrazine 4 lb/A	63	77*
None	Simazine 4 lb/A	63	61*
Plow and disk	Atrazine 2 lb/A	61	71*
None	Simazine 2 lb/A	56	61*
None	None	29	16
None	Plastic Mulch	10	20
All treatments ^{1/}		5.5	5.5

^{1/} Standard error for each mean in a species column.

* Significantly different (.05 level) from the last two treatments in a column (Snedecor 1956).

each tree was protected from weed invasion, weed growth was almost as dense as on check plots.

Plowing and disking stimulated rapid height growth of yellow-poplar and white ash seedlings but not of black walnut or red oak seedlings (table 3). After 2 years yellow-poplar was the only species that showed significantly better (8/32-inch more) basal

Table 3.—Average second-year height of planted hardwood trees on prepared and unprepared ground
(In inches)

Ground preparation treatment	Yellow-poplar	Black walnut	Red oak	White ash
Plow and disk	37*	28	12	25*
None	20	23	12	14
All ^{1/}	4.0	2.5	1.1	2.5

^{1/} Standard error for each mean in the species column.

* Significantly different from the number below (Snedecor 1956). Each mean based on 420 planted trees.

diameter growth on prepared than unprepared ground.

Recommendations and Precautions

Information gained from this study has been added to that of others to provide the following guides.

The planting site should be thoroughly prepared by fall plowing and spring disking and harrowing so that the herbicides can be applied on bare soil. Simazine and atrazine kill newly germinating annual broadleaf weeds and grasses, but perennial weeds and established plants may be unaffected. Simazine generally will not give satisfactory weed

control without prior ground preparation, but atrazine gives good control of smooth brome grass without preparing the ground.

Simazine or atrazine (wetable powder forms) must be applied in early spring so that sufficient moisture is available to move the herbicides into the weed seed zone before the seeds germinate. One-half to one inch of rainfall within 15 days after atrazine and simazine applications is required to move 4-pounds-per-acre rates into the zone where weed seeds germinate (Splittstoesser and Derscheid 1962).

Simazine can be applied before, simultaneously with, or after planting without injury to the tested species, but atrazine should be applied before planting; otherwise some injury can be expected. Both herbicides kill by their adverse effect on photosynthesis but since atrazine is 14 times more soluble than simazine (Crafts 1961), it is absorbed not only through the roots but also through the foliage. Simazine is absorbed only through the roots.

Four pounds per acre of active simazine or atrazine should be applied on silt loam soils, but only 2 to 2½ pounds per acre of active simazine on sandy soils. Higher rates of simazine and atrazine must be applied to control weeds on heavy soils (clay) and soils high in organic matter than on sandy soils. Soils high in organic matter or clay content reduce simazine phytotoxicity more than do soils low in these components (Burnside and Behrens 1961). We have used as much as 16 pounds per acre of simazine on a silty clay loam soil without injuring black walnut seedlings.

Atrazine cannot be applied safely on sandy soils because it is leached more rapidly (Rodgers 1962) and to greater depths than simazine. Seedlings may be injured or killed if the herbicides come in contact with tree roots. Simazine and atrazine remained in the upper inch of soil following furrow irrigation on a silt loam soil (Ashton 1961), but with heavy rainfall and increasing amounts of sand even small amounts of simazine are leached to greater depths (Burschel 1961).

Atrazine or simazine can be applied safely at recommended rates on 1-year-old black walnut, red oak, white ash, and yellow-poplar seedlings, but

younger seedlings may be injured or killed. Older seedlings may escape injury because their roots are below soil containing toxic amounts of herbicides (Kozlowski and Kuntz 1960).

The manufacturer's instructions should be followed, and your equipment should be calibrated so that the herbicides are uniformly applied. Even the most resistant tree species may be injured or killed if either herbicide is applied in sufficient quantity. Broadcast treatments are most effective on level planting sites, and 6- to 8-foot treated contour bands are recommended on sites subject to erosion.

The trees must be planted in an unright position and the soil packed firmly about the tree so that the herbicide cannot get to the tree's roots through cracks.

Literature Cited

- Ashton, F. M. 1961. Movement of herbicides in soil with simulated furrow irrigation. *Weeds* 9: 612-619.
- Burnside, O. C. and R. Behrens. 1961. Phytotoxicity of simazine. *Weeds* 9: 145-157.
- Burschel, P. 1961. Untersuchungen über das Verhalten von Simazin in Boden (Experiments on the breakdown of simazine in the soil). *Weed Res. (England)* 1: 131-141.
- Crafts, A. S. 1961. The chemistry and mode of action of herbicides. P. 105-112. New York: Interscience Publishers.
- Davis, D. E., H. H. Funderburk, Jr., and N. G. Sansing. 1959. The absorption and translocation of C¹⁴ labeled simazine by corn, cotton, and cucumber. *Weeds* 7: 300-309.
- Kozlowski, T. T., and J. E. Kuntz. 1960. Effect of simazine on red pine seedlings of varying age. *Univ. Wis. Forestry Res. Note* 62, 3 pp.
- Limstrom, G. A. 1963. Forest planting practices in the Central States. U.S. Dep. Agr. Handbook 247, p. 24.
- Rodgers, E. G. 1962. Leaching of four triazines in three soils as influenced by varying frequencies and rates of simulated rainfall. *Proc. So. Weed Control Conf.* 15: 268.
- Snedecor, G. W. 1956. Statistical methods. 5th ed. p. 253. Ames: Iowa State Univ. Press.
- Splittstoesser, W. E., and L. A. Derscheid. 1962. Effects of environment upon herbicides applied preemergence. *Weeds* 10: 304-307.